Space Weather Technical Forecast

Issued on Thursday, 16 March 2023 at 13:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Slight chance of a G1/Minor Geomagnetic storm on Day 1 (16 March).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low over the past 24 hours with two isolated C-class flares and a peak of C1.3 at 16/0643UTC from a region that is emerging over the eastern limb. There are currently eight numbered and two unnumbered sunspot regions on the visible disc. These are a mixture of mature spots and some more recently emerged spot groups. All are small and magnetically simple and are generally either stable or in decay, with some regions showing transient proliferation and decay of trailing spots.

No Earth directed CME's have been observed in the past 24-hours.

Solar Wind / Geomagnetic Activity: The solar wind has remained at or close to elevated levels throughout the last 24-hours with ongoing enhancement attributed to CME arrivals on 15 Mar and a coronal hole HSS. Wind speeds observed at L1 showed a sharp increase at 15/23335UTC to a peak of around 590 km/s. Winds then gradually declined and are currently around 510km/s. Density has been remained predominantly above average with a peak of 25ppcc at 15/2209UTC, but fell to average around 16/0700UTC where it has largely remained. The total IMF strength was mostly moderate, falling to weak around 15/2210UTC where it has remained. The north-south component was variable fluctuating between +13/-12nT, with a sustained period of moderately strong negative Bz observed 15/2000-2130UTC. The Phi angle was mostly positive (away from the Sun) but switched to negative (towards the Sun) 15/2040-16/0730UTC, with ongoing negative (towards the Sun) Bz commencing around 16/1100UTC.

Geomagnetic activity ranged Quiet to G2/Moderate Storm, with a G2/Moderate Storm interval observed at 15/2100-2400UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has remained at background to slightly elevated levels throughout, with a peak of 2pfu at 15/1215UTC. The high energy electron flux (greater than 2MeV) has been at largely background levels, with a peak of 108pfu at 15/1445UTC. The associated 24 hour

Electron fluence has been well below Active. At 16/0001UTC the observed fluence was 1.18e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to remain Low or Very Low, with a slight chance of an isolated M-class flare, most probable on Days 3-4 (18-19 Mar).

Solar Wind / Geomagnetic Activity: Solar winds are expected to remain at elevated or slightly elevated levels through Days 1-2 (16-17 Mar) with coronal hole high speed stream effects combined with waning CME influence from arrivals on 15 Mar. Wind speeds continuing to

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

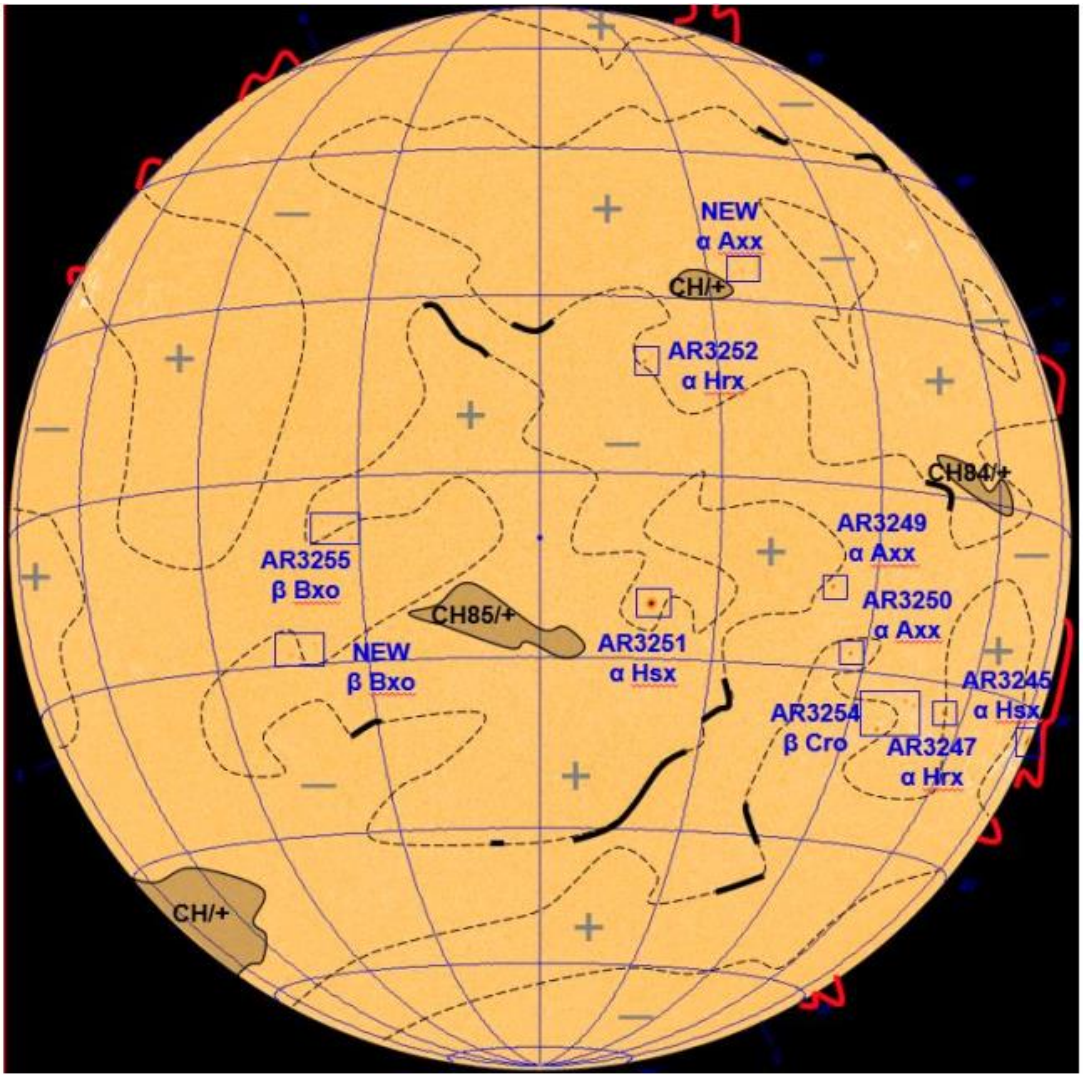
© Crown Copyright 2023. All Rights Reserved.

decline through Days 1-2, but weak enhancement is possible by the end of Day 4 (19 Mar) as connection to a HSS from CH85/+ becomes established.

Geomagnetic conditions forecast to be largely Quiet with some Unsettled intervals. Slight chance of Active intervals and of a G1/Minor Storm interval Day 1 (16 Mar). Possible further upturn in activity to Unsettled to Active by the end of the period, with a slight chance of a G1/Minor Storm interval.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux, as observed by GOES16, is expected to remain at or near background levels throughout. No further significant enhancements are expected at present. The high energy electron flux is expected to persist at largely Background levels on Day 1 (16 Mar), but is then likely to recover through the rest of period as the residual influence from CMEs and HSS wanes. Flux levels are likely to rise to Moderate, with a chance of reaching High levels by Day 3 (18 Mar). The associated 24 hour electron fluence is expected to persist at below the Active level, but with an upward trend during Days 2-4 (17-19 Mar).

Figure 1. Solar Analysis Valid 16/0800 UTC.

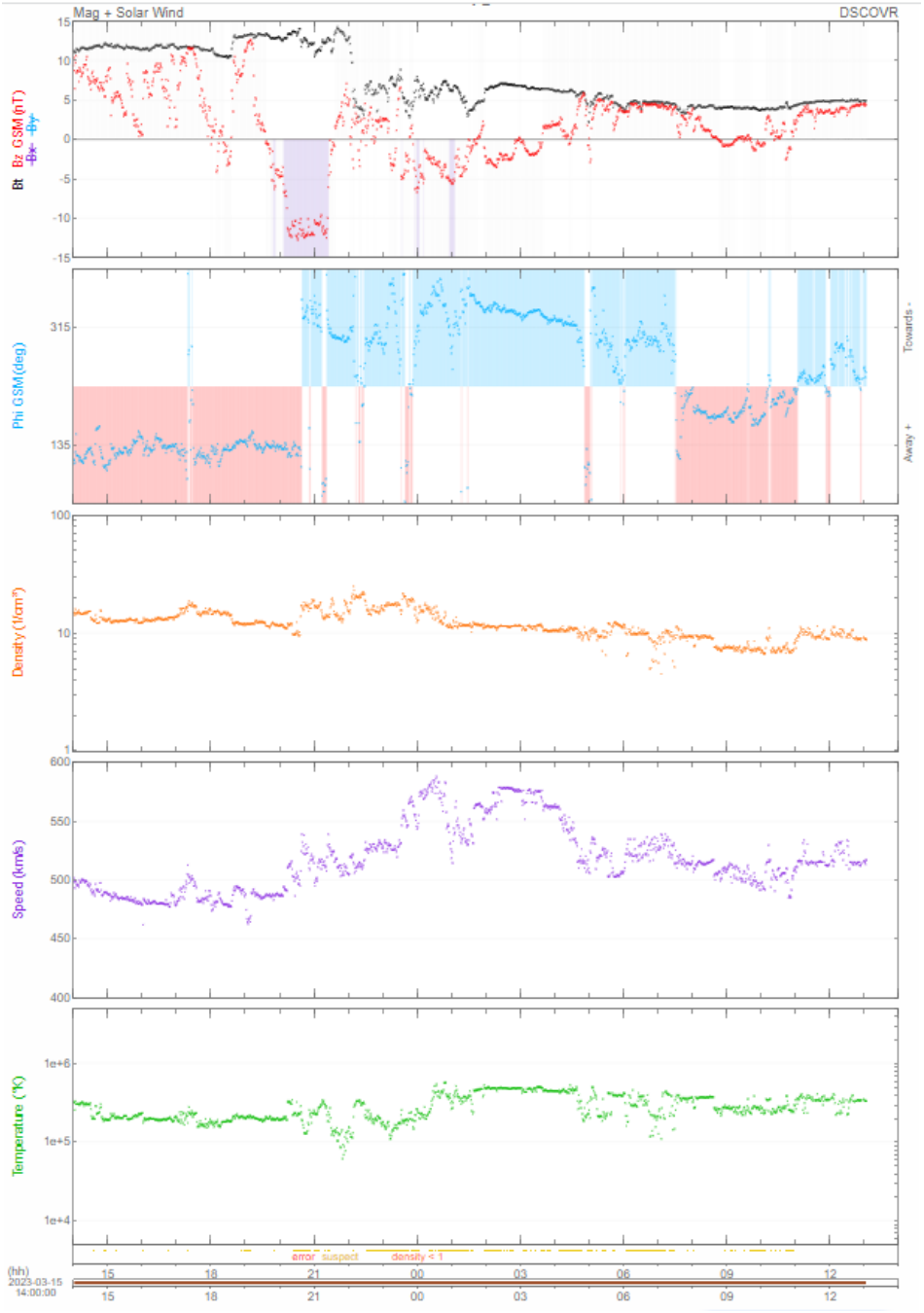


Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2. 24-hour solar wind data from DSCOVR - shows arrival of filament CME late 15 Mar



Geomagnetic Storms:

The solar wind is currently around 510 km/s. Solar wind speeds are expected to remain at elevated or slightly elevated levels through Days 1-2 (16-17 Mar) due to the combined effects of filament eruption CME arrivals on 15 Mar and a coronal hole high speed stream. These influences are likely to wane through Days 1-2, with wind speeds continuing to decline accordingly. By Day 4 (19 Mar) an enhancement to wind speeds is possible due to a weak connection to a HSS from CH85/+ becoming established.

Geomagnetic conditions are expected to be largely Quiet through the forecast period, with the occasional Unsettled interval. There remains a slight chance of Active intervals, and a slight and diminishing chance of a G1/Minor Storm interval through Day 1 (16 Mar). An uptick in activity is expected by the end of Day 4 (19 Mar), becoming generally Unsettled to Active with a slight chance of a G1/Minor Storm interval.

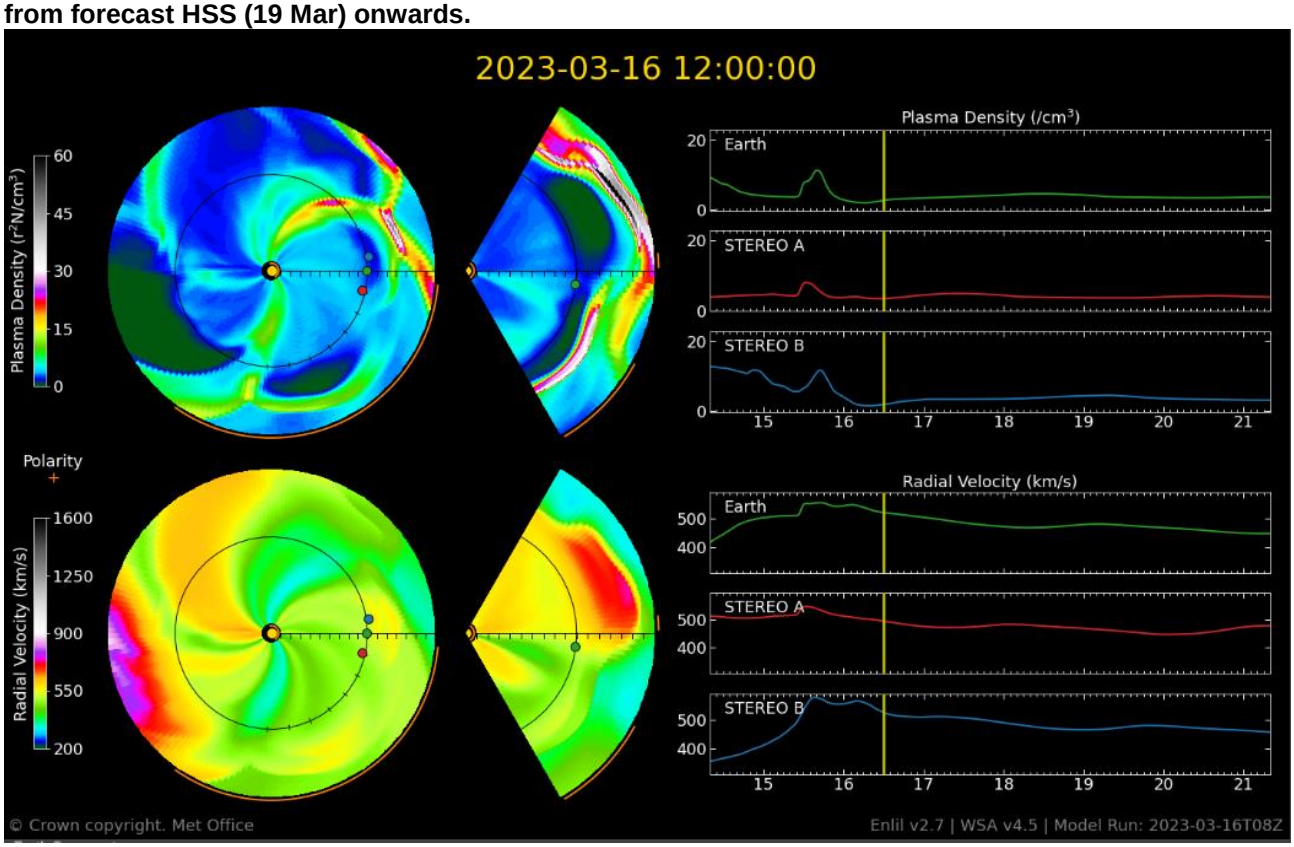
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	5	1	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections
Nil anticipated.

Figure 3: MOSWOC Enlil – Generally offering good guidance. Deficient in solar wind enhancement from forecast HSS (19 Mar) onwards.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
Solar activity has been Low over the past 24 hours with two isolated C-class flares and a peak of C1.3 at 16/0643UTC from a region that is yet to fully emerge from the eastern limb onto the visible disc.

There are currently eight numbered and two unnumbered sunspot regions on the visible disc. These are a mixture of mature spots and some more recently emerged spot groups. All of the regions are small and magnetically simple, and generally stable or in decay. Several regions, however, have shown some transient proliferation and decay of trailing spots. In addition to the spots, there are number of filaments on the disc, which should any erupt, could be another source of C-class flares.

Solar activity is expected to remain Low or Very Low, with a slight chance of an isolated M-class flare, most probable later in the forecast period. AR3245 (Hsx/Alpha) is due to rotate off the visible disc by the end of Day 1 (16 Mar). However, possible new or returning regions are anticipated to rotate around the eastern limb during the forecast period, bringing an associated increase in flare risk.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	5	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10 MeV) proton flux, as observed by GOES16, is expected to remain at background or slightly elevated levels throughout the forecast period.

Given the simplicity of the sunspot regions currently on the disc, no further significant enhancements are expected, unless any further large far-sided eruptions occur.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	Yes	5	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

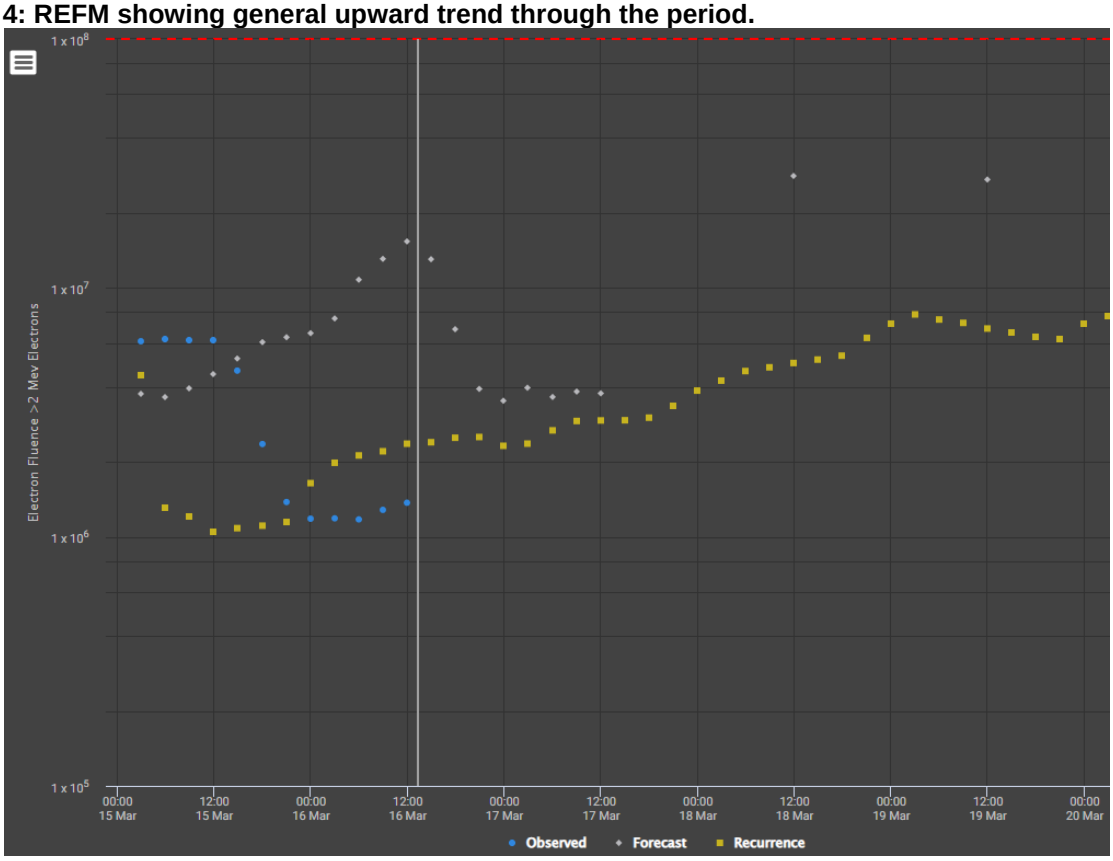
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux at GEO, as observed by GOES-16, is expected to persist at largely Background levels on Day 1 (16 Mar) but is then likely to recover through the remainder of the period as the residual influence from CMEs and HSS wanes. Flux levels will likely rise to Moderate, with a chance of crossing the threshold to High levels by Day 3 (18 Mar).

The associated 24 hour electron fluence is expected to remain below the Active level, gradually trending upwards during Days 2-4 (17-19 Mar), with only a slight chance of the Active threshold being reached late in the period. REFM is currently considered to be giving good guidance for the overall forecast trend.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: REFM showing general upward trend through the period.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.